Electronic Version
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Claims

[c1] A semiconductor device comprising:
a semiconductor base;
at least one copper wiring level on the semiconductor base;
a barrier layer on, and in direct contact with, the copper wiring level;
an aluminum bond pad on the barrier layer; and
a composite layer in addition to the barrier layer between the aluminum bond pad and the barrier layer wherein the composite layer comprises a refractory metal and a refractory metal nitride.

[c2] The semiconductor device of claim 1 wherein the composite layer comprises alternating layers of the refractory metal and the refractory metal nitride and there are at least two layers of each of the refractory metal and the refractory metal nitride.

[c3] The semiconductor device of claim 1 wherein the composite layer is directly on the barrier layer.

[c4] The semiconductor device of claim 1 wherein the composite layer is within the aluminum bond pad.

[c5] The semiconductor device of claim 1 wherein the aluminum bond pad comprises first and second layers and the composite layer is interposed between the first and second layers.

[c6] The semiconductor device of claim 5 wherein one of the first and second layers of the aluminum bond pad is in direct contact with the barrier layer.

[c7] The semiconductor device of claim 1 wherein the barrier layer is selected from the group consisting of tantalum nitride, tantalum nitride/tantalum and tantalum nitride/titanium/titanium nitride.

[c8] The semiconductor device of claim 7 wherein the thickness of the barrier layer is 500 to 1000 angstroms.

[c9] The semiconductor device of claim 1 wherein the refractory metal of the composite layer is selected from the group consisting of tantalum, titanium and tungsten and the refractory metal nitride of the composite layer is selected from the group consisting of tantalum nitride, titanium nitride and tungsten nitride.

[c10] The semiconductor device of claim 1 wherein the thickness of the aluminum bond pad is 0.5 to 2.0 microns.

[c11] The semiconductor device of claim 1 wherein the refrac-

tory metal of the composite layer is tantalum and the refractory metal nitride is tantalum nitride.

[c12] The semiconductor device of claim 1 wherein the refractory metal of the composite layer is titanium and the refractory metal nitride is titanium nitride.

[c13] The semiconductor device of claim 1 wherein the refractory metal of the composite layer is tungsten and the refractory metal nitride is tungsten nitride.

[c14] The semiconductor device of claim 1 wherein the composite layer is 1000 angstroms thick.

[c15] A method of manufacturing a semiconductor device comprising the steps of:
forming a semiconductor base;
forming at least one copper wiring level on the semiconductor base;
forming a barrier layer on, and in direct contact with, the copper wiring level;
forming a composite layer on the barrier layer wherein the composite layer comprises a refractory metal and a refractory metal nitride; and
forming an aluminum bond pad on the composite layer.

[c16] The method of claim 15 wherein the composite layer comprises alternating layers of the refractory metal and

the refractory metal nitride and there are at least two layers of each of the refractory metal and the refractory metal nitride.

[c17] The method of claim 15 wherein the composite layer is directly on the barrier layer.

[c18] The method of claim 15 wherein the composite layer is within the aluminum bond pad.

[c19] The method of claim 15 wherein the aluminum bond pad comprises first and second layers and the composite layer is interposed between the first and second layers.

[c20] The method of claim 19 wherein one of the first and second layers of the aluminum bond pad is in direct contact with the barrier layer.